PLASTIC TO FUEL: THE EFFECT OF REAL PLASTIC WASTES COMPOSITION

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ABSTRACT

Plastic is a major composition in municipal waste. Depleting of fossil fuel leads to exploration of alternative fuel production including converting plastic waste to fuel. The objective of this of study is to investigate the effect of real plastic waste composition on a pyrolysis process to fuels. Plastic wastes that compose of shampoo bottle, plastic bag, plastic wrapper and polystyrene were used. Thermal decomposition study of the plastic wastes was done by using Thermogravimetric Analysis. The catalyst used in this research is oil palm biomass ash catalyst. It was cleansed and calcined at 750°C (15°C.min^{-1}) for four hours. Then, the catalyst was then crushed and sieved to have homogenized size of < 125µm. The catalyst was characterized by using Scanning Electron Microscope (SEM) with Energy Dispersive X-Ray (EDX) and Brunauer, Emmett and Teller (BET). Nitrogen gas was used to provide oxygen free condition during the investigation. The plastic waste and catalyst weight ratio was set at 10:1. The catalyst was tested in a batch one litre borosilicate reactor and heated up to 450 °C for 30 minutes. The plastic wastes decomposed into liquid, solid residue and gas. The liquid product was collected in a condenser, while the uncondensed gas was collected in the gas bag. The composition of the liquid fuel was analyzed by using Mass spectrometry gas chromatography (GC-MS). The calorific value, moisture, density, turbidity, cetane and octane number of the liquid fuel were also determined. Gas composition of the gas product was determined via Thermal Conductivity Detector gas chromatography (GC-TCD). About 40% of liquid fuel was produced after the pyrolysis for shampoo bottle. The application of catalyst significantly improved the liquid production to 50% of liquid fuel. Liquid fuel quality with averagely high octane number for shampoo bottle and polystyrene are 100 and 98 respectively. Low moisture content (<3 %) was observed in all liquid fuels. The calorific value ranging from 2885.36 cal/g - 4209.31 cal/g was achieved for all plastics samples. A gas product that rich in methane (±3mol%) was obtained. In conclusion, the application of catalyst that derived from waste creates a low cost alternative fuel production via catalytic plastic waste pyrolysis.

ABSTRAK

Bahan fosil api yang semakin berkurang mengilhamkan kaedah bahan api alternatif termasuk menukar sisa plastik kepada bahan api. Objektif pengajian ini adalah untuk mengkaji kesan komposisi plastic sampah sebenar pada proses pirolisis kepada bahan api. Sisa plastik yang dikomposisikan daripada botol syampu, beg plastik, plastik pembungkus dan polistirena, telah digunakan. Kajian penguraian terma bagi sisa plastik telah dilakukan dengan menggunakan 'Thermogravimetric Analysis'. Pemangkin yang digunakan dalam kajian ini adalah pemangkin abu kelapa sawit. Ia telah dibersihkan dan dikalsin pada 750°C dengan 15°C.min^{-1} selama empat jam. Kemudian, pemangkin telah dihancurkan dan disaring untuk mempunyai saiz <125μm. Pemangkin telah dicirikan dengan menggunakan 'Scanning Electron Microscope' (SEM) dengan 'Energy Dispersive X-Ray' (EDX) dan 'Brunauer, Emmett and Teller' (BET). Gas nitrogen telah digunakan untuk menyediakan keadaan bebas oksigen semasa siasatan dijalankan. Sisa dan pemangkin nisbah berat plastik telah ditetapkan pada 10:1. Pemangkin ini telah diuji di dalam satu liter borosilikat reaktor dan dipanaskan sehingga 450° C selama 30 minit. Sisa plastik telah diuraikan kepada cecair, sisa pepejal dan gas. Produk cecair telah dikumpulkan di dalam pemeluwap, manakala gas yang tidak meluwap telah dikumpulkan dalam beg gas. Komposisi bahan api cecair telah dianalisis dengan menggunakan 'Mass spectrometry gas chromatography' (GC-MS). Jumlah nilai kalori, kelembapan, ketumpatan, kekeruhan, cetana dan oktana bahan api cecair juga telah ditentukan. Komposisi gas produk gas telah dianalisis melalui 'Thermal Conductivity Detector gas chromatography' (GC-TCD). Sebanyak 40% bahan api cecair diperloleh selepas pirolisi. Pengunaan pemangkin menunjukkan peningkatan yang ketara kepada 50% bahan api cecair. Kualiti bahan api cecair dengan purata nombor yang tinggi iaitu 100 oktana untuk botol syampu dan 98 untuk polistirena, kandungan lembapan yang rendah (< 3%). Rangkaian nilai kalori petrol yang bermula daripada 2885.36 kalori/g – 4209.31 kalori/g dan produk gas yang kaya dengan metana (± 3 mol%) telah diperolehi untuk semau jenis plastik. Kesimpulannya, pengunaan pemangkin yang terhasil daripada sisa menghasilkan bahan api alternatif yang berkos rendah.
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